Why Water-Assisted Injection Moulding? 
Advantages and Equipment

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Gas- and Water-Assisted Injection Moulding 
19th. and 20th. September 2007 
Warwick University, Coventry
Water- Assisted Injection Moulding

The process of water-assisted injection moulding was developed at the “Institut für Kunststoffverarbeitung (IKV)” of the University in Aachen, Germany.

Aquamould® is based on the developments and experiences of the IKV, where Battenfeld have a close cooperation.
Water- Assisted Injection Moulding

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What are the advantages of water?

• Low cost media
• No remaining ingredients of water in mouldings
• Water is incompressible
• Direct internal cooling of mouldings
# Water-Assisted Injection Moulding

## Aquamould®

<table>
<thead>
<tr>
<th></th>
<th>Nitrogen 1 bar, 20 °C</th>
<th>Water 1 bar, 20 °C</th>
<th>&gt; Factor 40</th>
<th>&gt; Factor 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal conductivity</td>
<td>0.0143</td>
<td>0.604</td>
<td></td>
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<tr>
<td>$\lambda$ [W/m K]</td>
<td></td>
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<tr>
<td>Specific heat capacity</td>
<td>1038</td>
<td>4182</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$c_p$ [J/kg K]</td>
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**Advantages:** Reduced cooling times compared to gas-assisted injection moulding

Reference: IKV Aachen
Water-Assisted Injection Moulding

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Tube, 10 mm diameter

Surface temperature after demoulding
Photo taken by infrared camera

With Aquamould:
Shorter cooling times

Gas – Airmould

Water – Aquamould
Water- Assisted Injection Moulding

Process variants:

Short-shot process
Back to screw process
Overflow process

Limitation:

Water injection through machine nozzle is not possible.
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Advantage:
Smooth surface of internal channels

Body side panel

Arm rest, thick wall

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Advantage:
Even wall thickness distribution

Pipe, 10 mm diameter, PA 6
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Advantages:
Large diameters with even wall thickness distribution

Tube
• Polymer: PP
• Diameter: 60 mm

More even residual wall thickness due to internal cooling by water
Water-Assisted Injection Moulding

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Advantage:
Can be also used for large wall thickness

Media ducts with functional elements,
ABS
Wall thickness:
2-20 mm
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Advantages:
Suitable for large wall thickness

TPE

Tube with V-Connection
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Advantages:
Suitable for long flow paths

Test mould
Length: 3.000 mm
Polymer: PS

Advantage:
Even channel diameter over full length of moulding

Quelle: IKV Aachen
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Moulding suitable for Aquamould:

Aesthetic products

- High aesthetic requirements for surface quality

Functional products

- High requirements for interior surface quality

Examples

Grab handles
Toys
Thick wall products
...

Examples

Tubes and pipes
Media ducts
...
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- Economical and innovative process
- No competition to Airmould® - an additional process
- Competiton to 3-D blow moulding
- Suitable for a large range of polymers (PP, PA, ABS, PBT, PA-GF, TPE, etc.)
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Water injection

Water nozzle

Water injection and exit

Shut-off nozzle

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How to get the water out of the moulding?

- By gravity
- Blow out by compressed air at a remote position
- Injection of compressed air through water nozzle
- Use of vacuum
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The Aquamould® Modular System:

- Pressure generating systems for water, series WE
- Mobile control cabinet
- Pressure control modules
- Nozzles for water injection
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Pressure generating systems for water, Series WE:

• Accumulator for high water flow: > 1 l/s
• One WE unit can serve 2 injection machines
Water-Assisted Injection Moulding

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Pressure generating systems for water, series WE:

• Accumulator for high water flow: > 1 l/s
• One WE unit can serve 2 injection units

Pressure generating unit for Water: WE 100
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Mobile control cabinet Unilog B 4 AC

• Same interface for Airmould and Aquamould:
• Euromap 62
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Pressure control modules for water

- Precise pressure build-up
- Leak free valves
- Connection via electrical supply only
- Small compact units
- Can be positioned close to the mould
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Requirements for water injection nozzles (water injectors):

- Small dimensions
- Large diameters for increased water flow
- Active opening and closing functions
- Leak free
- Easy installation
Water injection nozzles:

- Excellent separation between water and oil
- Proximity switches for stroke control
- Easy installation

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Example:
Water nozzle injecting direct into the mould cavity
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How to get the water out of the moulding?

• By gravity
  • 1 injector is sufficient

• Alternating injection of compressed air through water injector
  • 1 injector sufficient

• Evacuation
  • 1 injector sufficient

• Blow out by compressed air at a remote position
  2 injectors required (additional air injection)
Water-Assisted Injection Moulding

Electronic control and measuring device for wall thickness

Pressure control module mounted beneath the mould

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**Water-Assisted Injection Moulding**

**Combination of Processes**

**Multifoam Process:**
Water-assisted injection moulding with Co-injection

**Cross section of media duct:**
- **Skin:** PA 66, 30% GF
- **Core:** PP 20% GF

**Hollow section formed with Aquamould**

*Quelle: IKV Aachen, Schukmann*
Water-Assisted Injection Moulding

Co-injection Technology

Machine Technology

HM 270/1330 H/1000 H Unilog B 6

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Water-Assisted Injection Moulding

Multifoam Process

Combination of mechanical strength and chemical resistance

Cross section of media duct

- Skin: PA 66, 30% GF
- Core: PP 20% GF

Hollow section formed with Aquamould

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Quelle: A. Schulmann
Water-Assisted Injection Moulding

Combination of Processes

Multi-component injection moulding and Aquamould

Soft ball racket

- Frame, PP, grade 1
  Hollow section by Aquamould
- Contact area, PP, grade 2

Advantages:
- Strong and light frame with hollow section
- Short cycle time by direct internal water cooling

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Water- Assisted Injection Moulding

Combination of Processes

Multi- component injection moulding and Aquamould

TM 2100/ 1000+ 525 S with Aquamould
Pressure generating unit WE
Mobile control cabinet with pressure control module for water
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Three wheel bike for kids: Handle-bar and fork, PP
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Three wheel bike for kids: Handle-bar and fork, PP

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Clutch pedal, VW:

Aquamould clutch pedal replaces hybrid solution:
PA 6 GF 30 GF 30

Right:
Metal insert, overmoulded with PA 6 GF 30

Middle and left:
All plastic solution with Aquamould
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The Start

Hybrid moulding

Steel insert app. 200g

Plastic (PA GF30) app. 200g

∑ = 400 g
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The Target

- Vehicle weight reduction
- Cost reduction (Cycle time and production cost)
- Reduction of processing steps
- Improved recycling possibilities
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The Solution

All Plastic Moulding (PA6 GF30)
using short shot process

ca. 200g

By water-assisted injection moulding
Water-Assisted Injection Moulding

The Solution

All Plastic Moulding (PA6 GF30)
using short shot process

By water-assisted injection moulding

ca. 200g
Water-Assisted Injection Moulding

The Process

- Injection of polymer (Melt pre-filling)
- Water injection (complete filling of cavity)
- Water release
- Measuring of residual wall thickness by Ultrasonics
- Ejection of moulding

Quelle: Entwicklung 3-PBP-2/2

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The Results

- Cost reduction app. 10%
- Weight reduction app. 50%
- Cycle time reduction app. 30%
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Now see a video sequence of the clutch pedal production
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Handle for car seat adjustment:
PA 6 GF 30, produced by Aquamould:
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